Benefits of Fiscal Policies on Sugar-Sweetened Beverages

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Objectives: Overweight, obesity, and their associated chronic diseases have become prevalent in many developing countries in Asia, defining them as major public health issues. One of the main contributors to overweight and obesity is the consumption of sugar-sweetened beverages (SSB). In this article, we reviewed the latest literature examining the benefits of a SSB tax. **Methods:** A systematic literature review was conducted on: (i) policy documents and government reports to examine the current applications of SSB taxation; and (ii) published studies on price elasticity of demand (PED) of SSBs to examine the health and economic benefits of SSB taxation. **Results:** Articles included in our review have used or estimated negative PED, ranging from -0.63 to -1.3, and have shown an associated decrease in BMI and prevalence of overweight and obesity. **Conclusion:** Most studies so far have focused on the health and economic impacts of SSB taxation among high- and upper-middle income countries. Further research is needed to understand the impact of SSB taxation on lower-middle and low-income countries, which are facing comparable, if not more serious, obesity and overweight threats.

Keywords: Obesity, Overweight, Beverages, Carbonated Beverages, Fiscal Policy, Taxes

Introduction

Overweight and obesity are adverse medical conditions of "abnormal or excessive body fat accumulations in adipose tissue" [1, 2]. The etiology of obesity and overweight is related to many environmental, behavioral, and genetic factors. However, the main cause of obesity and overweight is an energy imbalance between calories consumed and calories expended. This imbalance is widened by an increasing intake of energy-dense foods, high in fat and sugars, and a decrease in physical activity, due to the expansion of sedentary lifestyles and urbanization [3].

An excessive consumption of sugar-sweetened beverage

(SSB) products leads to a disproportionate intake of refined carbohydrates, among which is sugar. As a result, both the triglyceride level and blood pressure increase, and the level of high-density lipoprotein cholesterol decreases, inducing higher risks of coronary heart diseases [4]. Consumption of SSBs induces high glycemic load, causing insulin resistance and directly affecting pancreatic islet cells, and thus, raising the risk of contracting diabetes [5]. Tchkonia et al. have shown the association between the consumption of SSBs and markers of insulin resistance [6]. Sugar in liquid form has poor satiating properties, and thus, the consumption of SSBs facilitates excessive weight gain [7].

Though carbohydrates are crucial for human metabolism and energy intake, the consumption of SSBs is associated with neither a healthy diet nor appropriate energy intake [8]. Many researchers have concluded that using fiscal policies to reduce the intake of "free sugars" (monosaccharides and disaccharides added to foods) or other added sugars, from sources such as SSBs, could be the most significant intervention available to reduce the burden of overweight, obesity, and their related chronic non-communicable diseases [9, 10].

Formerly considered a concern primarily among developed countries, overweight and obesity has now reached high prevalence in many low- and middle-income countries, especially in urban areas [11]. Researchers have found a higher prevalence of obesity among higher socioeconomic groups in low-income countries, and in contrast, a higher prevalence of obesity in lower socioeconomic groups in middle and high-income countries [12-14].

Taxation is considered to be the most cost-effective intervention for governments to reduce obesity and related non-communicable diseases [15]. SSB taxes are referred to as two-sided benefits policies because they both generate fiscal revenues for the short term and reduce SSB consumption for the long term (Figure 1). Several states in the USA and countries in Europe, Asia Pacific, and Sub-Saharan Africa have already introduced various types of SSB taxation systems. No matter the level of economic development or level of economic growth, countries around the world, including the UK and Mongolia, have proposed or are planning to propose SSB taxation systems.

The aim of this study is to inform future policy making by examining the current situation of SSB taxation around the world and reviewing studies that have analyzed the potential benefits of SSB taxes. Using an interdisciplinary approach of combining both economic and public health insight, this study aims to provide country-based and evidence-based information on economic and health impact of SSB consumption following the introduction of SSB taxes. Our paper intends to build a meta-analysis of SSB taxation to herald public policy makers in low-middle income countries about the significance and relevancy of introducing fiscal policies in order to reduce overweight and obesity.

Low-middle income countries, including Central Asian countries such as Mongolia, are under researched on this topic. According to the findings of the fourth and the fifth National Nutrition Study in Mongolia, the prevalence of overweight and obesity among children, adolescents, and adults has doubled between 2010 and 2017 [16, 17]. Furthermore, the Mongolian
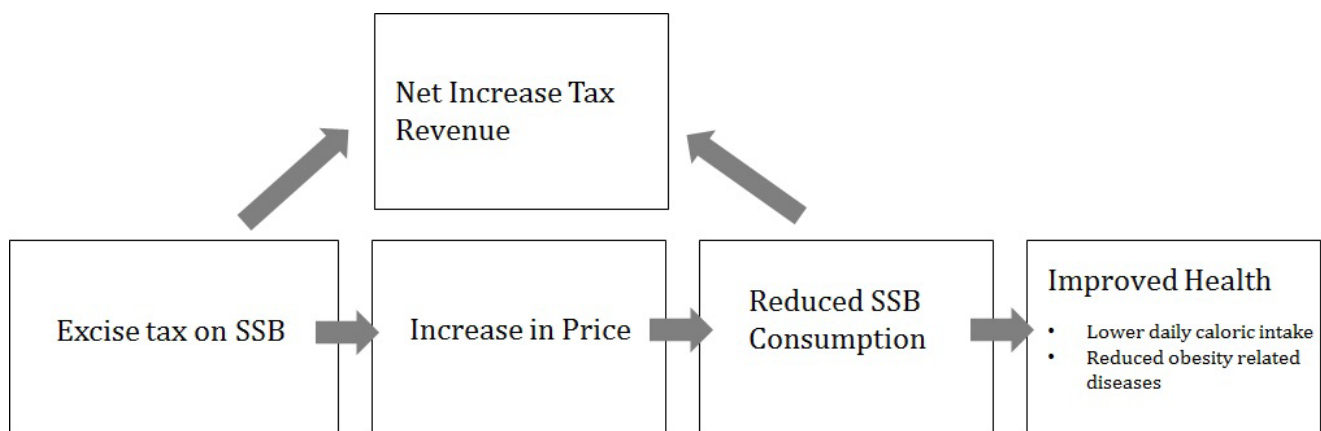

Figure 1. Short and long term benefits of SSB taxes

government has started thinking about introducing a sugar tax in Mongolia. Thus, this literature review constitutes a first step in conducting deeper research on SSB taxes, overweight, and obesity in Mongolia.

The first section presents the materials and methodology used. The second section exposes the current applications of SSB taxation. The third section gathers an up-to-date country/region specific evaluation of SSB price elasticities. The fourth section reviews the health impacts of SSB taxation, and the last section discusses research guidelines for future contribution.

Materials and Methods

1. Methodology
A systematic literature review was conducted according to the two parts of our review: (i) policy documents and government reports were searched to examine the current applications of SSB taxation; and (ii) modeling studies and meta-analysis of price elasticities of demand of SSBs were searched to examine the health and economic benefits of SSB taxation.

2. Inclusion and exclusion criteria
We included articles published between 2008 and 2017 in public health and economic journals. We included articles describing the health and economic benefits of fiscal policies related to SSBs assessed for the general population, including adults and children, male and female, and from all economic backgrounds and country settings. We also included articles focusing on overweight and obese individuals. However, articles focusing on particular subgroups, specific diseases, conditions, or metabolic disorders were excluded.

3. Definitions
We used the definition of SSB from the Centers for Disease Control and Prevention (CDC): SSBs contain added caloric sweeteners, which include natural sweeteners such as honey and concentrated fruit juice [18]. Therefore, soft drinks, sodas, fruit drinks, sweetened coffees and teas, energy drinks, sports drinks, and sweetened waters were included. Artificially sweetened (e.g. with aspartame or saccharin) beverages, alcoholic beverages, and 100% fruit or vegetable juices were excluded. We reviewed

articles with any type and level (local, national, regional, and international) of SSB taxation.

The concept of price elasticity of demand (PED) is crucial in estimating the economic impact of a tax on consumption. PED is defined as the percentage change in purchased quantity in response to a one percent change in price. Most products (except luxury products or Giffen goods) have a negative PED, i.e. an increase in price leads to a decrease in demand. The higher the absolute value of PED, the higher the sensitivity to price and the more the demand decreases [19]. Therefore, estimating context-specific PEDs enables us to assess the consumer responses to an increase in price induced by taxation. The negative PED of a product signifies that it is economically appropriate to tax unhealthy products, and the absolute value of the PED helps determine the economically appropriate level of taxation to introduce.

4. Search strategy and Sources
The main search terms included 'ssb', 'sugar-sweetened beverages', 'carbonated beverages', 'soft drinks', 'tax', 'model', 'body mass index', 'obesity', 'overweight', 'health impact', and 'economic impact'.

Sources and references were searched through electronic databases, including the Cochrane Database of Systematic Reviews (CDSR) via Cochrane Library (2008 to present) and Medical Literature Analysis and Retrieval System Online (MEDLINE) (2008 to present); websites of professional organizations, including the World Obesity Federation (www.worldobesity.org), the Obesity Society (TOS: www.obesity.org), the Organization for Economic Co-operation and Development (OECD: www.oecd.org), the World Health Organization (WHO: www.who.int), the European Commission (EC: https://ec.europa.eu/commission/index_en), the Center for Disease Control and Prevention (CDC www.cdc.gov), National Institute for Health and Care Excellence (NICE: www.nice.org.uk), the World Trade Organization (WTO: www.wto.org), and the World Cancer Research Fund Institute (www.wcrf.org); and other sources, including the System for Information on Grey Literature in Europe (Open Grey) via INIST/CNRS, Social Science Research Network (SSRN e-Library) via SSRN, and National Bureau of Economic Research (NBER) via NBER.

Table 1. Summary of SSB taxed countries/territories/states by region and income classification

Country (World Bank Income Classification)	Types of Tax	Tax Rates	Taxed Products	Excluded Products	Year of Introduction and Revision
East Asia and Pacific					
American Samoa (III) [20]	Import duty and excise tax	0.15 USD per 12 ounces	All kinds of carbonated beverages and syrups		1963
Australia (IV) [21, 22]	Goods and service tax	10% on goods	Soft drinks and flavored milk	Fresh products	2001
Cambodia (II) [23]	Excise tax	10%	All kinds of SSBs		2004
Cook Islands (IV) [24]	Excise tax	NZD 9.8 per kg of sugar in drink	Added sugar containing beverages	Artificial sweetened water	2014
Fiji (III) [24]	Import duty	32%	Soft drinks	n/a	2011
French Polynesia (IV) [25]	Import duty and excise tax	XPF40 per liter on domestically produced SSBs; XPF 60 per liter on imported SSBs	Sweetened beverages	n/a	2002 and 2011
Kiribati (II) [26]	Excise tax	40%	SSBs, or any sweeteners	n/a	2014
Korea, Rep. (IV) [27]	VAT	10%	All kinds of processed foods		
Lao PDR (II) [28]	Excise tax	10%	SSBs	n/a	2013
Republic of Marshall Islands (III) [29]	Import duty	USD 0.0014 per 10 ounces of carbonated beverages; 6.666% for non-carbonated soft drinks	Carbonated and non-carbonates soft drinks with added sugar	n/a	2004, 2016
Federated States of Micronesia (II) [29]	Import duty and excise tax	25%	Sugar added drinks, prepare products	n/a	2004
Nauru (III) [29, 30]	Import duty	30%	Sugar and sugar containing products	Water	2007 and 2010
Northern Mariana Islands (IV) [31]	Excise tax	USD 0.005 per fluid ounce	Carbonated and non-carbonated soft drinks	Fruit juice, vegetable juice, bottled water, tea, tea products	1979 and 1995
New Caledonia (IV) [29]	Import duty	5% for fruit juices, 10% for soft drinks	Soft drinks and fruit juices		
Palau (IV) [29]	Import duty	USD 0.28175 per liter	SSBs with added sugar or other sweeteners	Water, fruit juice, vegetable juice	2015
Papua New Guinea (II) [32]	Import duty	10% and 15%	Fruit containing sweetened water and beverages,		2012
Samoa (III) [25]	Import duty and excise tax	WST 0.40 per liter	Carbonated beverages, all kinds of non-alcoholic beverages, syrups	n/a	1984, 2001
Solomon Islands (II) [29]	VAT	10%	All kinds of SSBs		
Tonga (III) [29]	Excise tax	TOP 1 per liter	Carbonated beverages		2013
Vanuatu (II) [29]	Excise tax	VUV 50 per liter	Carbonated beverages with added sugar or other sweeteners	n/a	2014
Europe					
Denmark (IV) [33]	Excise tax	DKK 1.64 per liter	Soft drinks	n/a	1930-2014
Finland (IV) [34]	Excise tax	EUR 0.22 per liter	Soft drinks containing more than 0.5% sugar	Water and milk	1940; 2014
France (IV) [34, 35]	Excise tax	EUR 7.16 per hectoliter in 2012 and EUR 7.53 per hectoliter in 2016	Beverages with added sugar	Milk, sugar added drinks for medical purpose, tea and coffee	2012 and 2016

Hungary (IV) [34]	Excise tax	HUF 7 per liter on soft drinks; HUF 200 per liter on syrup	Soft drinks, syrup (>8 gr per 100 ml)	Beverages with fruit and vegetable content >25%; >50% raw-milk beverages	2011 and 2013
Ireland (IV) [36]	Excise tax	Same as UK			from April, 2018
Norway (IV) [37]	Excise tax	NOK 7.66 per kg of sugar	Sugar and sugar added products	n/a	2016
United Kingdom (IV) [38]	Excise tax	24p per liter on drinks ≥8gr sugar in 100 ml; 18p per liter on drinks 5<sugar>8	Soft drinks	Fruit juice and dairy products	from 2018
South Asia					
Bangladesh (II) [39]	Processing duty	25%	Soft drinks and energy drinks	n/a	2014
Latin America and the Caribbean					
Barbados (IV) [40]	Excise tax and VAT	Excise: 10% VAT: 11.75%	SSBs	Fruit juices with 100% natural sugars	2015
Chile (IV) [41]	Ad-valorem tax	18% for soft drinks (>6.25 gr in 100 ml) and 10% in flavored water (<6.25 gr in 100 ml)	Soft drinks, flavored water and sport drinks	n/a	2015
Dominica (III) [42]	Excise tax	XCD 0.20 per liter; 10% for energy drinks	Soft drinks and energy drinks	n/a	2015
Mexico (III) [43]	Excise tax	MXN 1 per liter	SSBs and sugar containing mix powders	Dairy products, non-caloric products	2014
St. Helena Islands (IV) [44]	Excise tax	SHP 0.75 per liter	Carbonated beverages containing >15 gr sugar per liter	n/a	2014
Sub-Saharan Africa					
Mauritius (III) [45]	Excise tax	MUR 0.03 per gram of sugar	Carbonated beverages, fruit juices and syrup	n/a	2013 and 2014
South Africa (III) [46]	Excise tax	20%	SSBs	n/a	2017
North America					
US (IV) [47-51]	Various	0-7%	SSBs containing added sugar, syrups, and mix powder with sugar	Various, depends on city or state	1920 and 2015
Berkeley and Albania, California, US	Excise tax	USD 0.01 per fluid ounce	SSBs and added caloric sweeteners	100% fruit and vegetable concentrates, natural sweeteners, milk, beverages for medical purpose	2015 for Berkeley, 2016 for Albania
Cook County, Illinois, US	Excise tax	USD 0.02 per fluid ounce	Soft drinks		July, 2017
Boulder, Colorado, US	Excise tax	USD 0.02 per fluid ounce	Soft drinks		July, 2017
Philadelphia, Pennsylvania, US	Excise tax	USD 0.015 per fluid ounce	SSBs and added caloric sweeteners	beverages for medical purpose, ≥50% dairy products, ≥50% fruit and vegetable products	2016 and 2017
San Francisco, California, US		USD 0.01 per fluid ounce	Soft drinks		From 2018
Oakland, California, US		USD 0.01 per fluid ounce	Soft drinks		July 2017

(I) - Low income country; (II) - Lower-middle income country; (III) – Upper-middle income country; (IV) – High income country
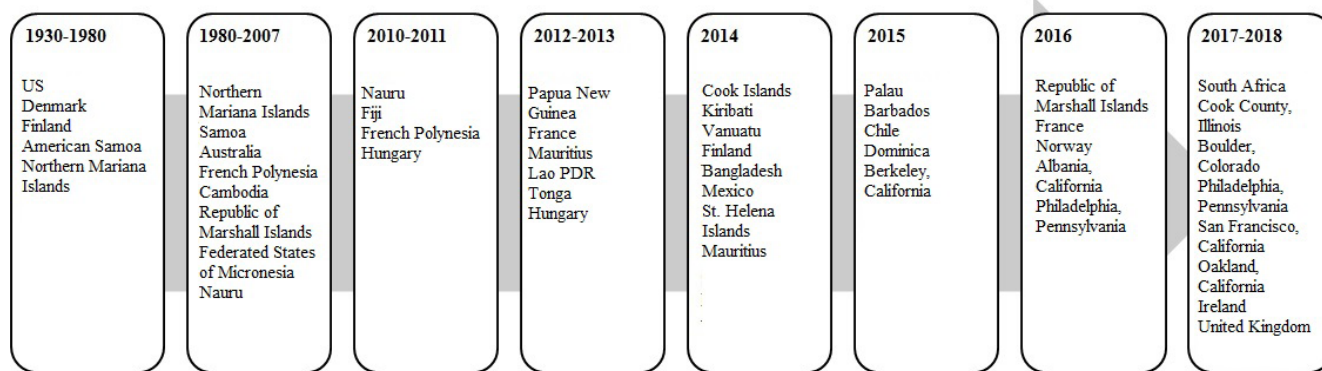
Figure 2. Timeline of SSB taxation introductions and revisions by country/territory/state

Table 2. Overview of included articles

Author	Pub. Year	Study design	Outcome reported	Population
Andreyeva, T. [55]	2010	Systematic review	Change in consumption	USA
Andreyeva, T. [62]	2011	Modeling study	Revenue generation	USA
Lin, B. H. [49]	2011	Modeling study	Health impact	USA
Briggs, A. D. [38]	2013	Modeling study	Health impact	UK
Briggs, A. D. [66]	2013	Modeling study	Health impact	Ireland
Cabrera Escobar, M. A. [54]	2013	Meta-analysis	Health impact	USA, Brazil, Mexico, France
Mekonnen TA [63]	2013	Modeling study	Health impact	US
Manyema, M. [59]	2014	Modeling study	Health impact	South Africa
Powell, L. M. [48]	2014	Macroeconomic simulation model	Employment impact	Illinois and California, US
Sharma, A. [64]	2014	Modeling study	Health impact	Australia
Basu, S [69]	2014	Modeling study	Health impact	India
Kristensen, A.H. [61]	2014	Micro simulation analysis	Health Impact	USA
Ruff, R. R. [47]	2015	Modeling study	Health impact	New York, USA
Long, M. W. [50]	2015	Modeling study	Health and economic impact	USA
Manyema, M. [58]	2015	Modeling study	Health impact	South Africa
Manyema, M. [60]	2016	Modeling study	Health impact	South Africa
Veerman, J. L. [65]	2016	Modeling study	Health impact	Australia
Backholer, K. [53]	2016	Systematic review	Health impact	High Income Countries
Sanchez-Romero, L. M. [57]	2016	Modeling study	Health impact	Mexico
Schwendicke, F. [68]	2017	Modeling study	Health impact	Germany
Jones Amanda C [67]	2017	Modeling study	Health impact	Canada
Barrientos-Gutierrez, T. [56]	2017	Modeling study	Health impact	Mexico

Table 3. Comparative analysis of SSB own-price elasticity

Country/Region	Price elasticity	Reference
High Income	-0.63 to -1.3	
High-income countries	-0.49 to -1.44	Backholer [53]
USA	-0.79	Andreyeva [55]
USA	-0.80	Andreyeva [62]
New York City, USA	-1.04	Ruff [47]
USA	-0.46 to -0.70	Lin [49]
USA	-1.21	Long [50]
California, USA	-0.79 to -1.0	Mekonnen [63]
Illinois and California, USA	-1.21	Powell [48]
USA, Brazil, Mexico, France	-1.30	Cabrera Escobar [54]
Germany	-0.90 to -1.20	Schwendicke [68]
Australia	-0.63	Veerman [65]
Australia	-0.63	Sharma [64]
Canada	-1.30	Jones [67]
Ireland	-0.90	Briggs [66]
UK	-0.77 to -0.83	Briggs [38]
Middle-Upper Income	-0.72 to -1.30	
Mexico	-0.72 to -1.30	Sanchez-Romero [57]
Mexico	-0.72 to -1.30	Barrientos-Gutierrez, [56]
South Africa	-1.30	Manyema [54, 58-60]
Low Income		
India	-0.94	Basu [69]

Results

1. Current applications of SSB taxation

The first part of our systematic literature review was to search policy documents and government reports to examine the current applications of SSB taxation. Taxation on SSBs as a policy intervention to reduce overweight and obesity have been extensively studied in the literature. Twenty countries in East Asia and Pacific region (American Samoa, Australia, Cambodia, Cook Islands, Fiji, French Polynesia, Kiribati, Rep. of Korea, Laos, Rep. of Marshall Islands, Fed. States of Micronesia, Nauru, Northern Mariana Islands, New Caledonia, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu), seven countries in Europe (Denmark, Finland, France, Hungary, Ireland, Norway, UK), one country in South Asia (Bangladesh), five countries and a territory in Latin America and the Caribbean region (Barbados, Chile, Dominica, Mexico, St. Helena Islands), two countries in

Africa (South Africa and Mauritius), one country in North America (various states of the US) have implemented or have decided to implement a tax on SSBs. As observed, our literature review not only encompassed high and upper-middle income countries but also many lower-middle and low-income countries. Taxation on SSBs has been designed through various levels and forms, based on each county's economic status and sociopolitical environment. Table 1 summarizes the current applications of SSB taxation by region and income group, and Figure 2 shows the timeline of the introduction and revision of the SSB taxation around the world [20-52].

Some countries tax only soft drinks, whereas others also tax drinks with added sugar (e.g. sweetened milk, sweetened fruit juices, and sweetened yogurt) or ingredients (e.g. instant powder or syrup for quick preparation). SSB taxes are based on volume, weight, sugar content, or product type (e.g. importation, fruit content). Levels of taxation differ by countries and territories. For

example, they vary by state in the USA, ranging from 0% to 7%. Excise taxes reach 10% in Barbados, Cambodia, Laos, Solomon Islands, and South Korea. The highest taxation levels are set in South Africa (20%), Bangladesh (25%), Federated States of Micronesia (25%), and Kiribati (40%). Countries in the Pacific Islands collect import duties on SSBs.

2. SSB price elasticities of demand

The second part of study was to search for systematic reviews, meta-analyses, and modeling studies on the PED of SSBs to examine the economic and health benefits of SSB taxation. Out of 96 articles found by keyword searching, we excluded 74 articles and included 22 articles according to exclusion and inclusion criteria (Table 2). Among the included articles, three were systematic review or meta-analyses: the first one focused on high income countries, the second one covered Brazil, France, Mexico, and the USA, and the last one compared several states in the USA [53-55]. Out of the 19 modeling studies articles, two were on Mexico, three on South Africa, seven on the USA, two on Australia, one on Ireland, one on the UK, one on Canada, one on Germany, and one on India [38, 47-50, 53-57, 61-69].

Within the studies conducted in high-income countries, PEs ranged from -0.63 to -1.3. In the USA, PEs ranged from -0.79 to -1.00 [50, 55]. In Germany, there was no country specific own-or cross-PE, thus the authors used PEs of -0.9 to -1.2 from a previously published article [68]. In Australia, own- and cross-PE was estimated using the Almost Ideal Demand System (AIDS) as -0.63 [64, 65]. In Canada, a PE of -1.3 from a meta-analysis by Cabrera Escobar et al. was used [54]. In Ireland, a PE of -0.9 was used [66]. In the UK, PEs ranged from -0.77 to -0.83 [38]. Within the studies conducted in upper-middle income countries, own-PE ranged from -0.72 to -1.3 In Mexico, PEs ranged from -0.72 to -1.30. In South Africa, there is no country specific own- and cross-PE, thus the authors used a PE of -1.3 from a previously published article [54, 58-60]. We found one article estimating the impact of SSB tax in a low-income country. In India, the own-PE was estimated as -0.94 [69].

A meta-analysis by Cabrera Escobar et al. conducted on 9 articles and across 4 countries led to a pool own-PE of -1.299 [54]. A systematic review based on 160 original articles from USA showed that the PE of soft drinks were -0.79 and the PE of juice was -0.76 [55]. Table 3 and Figure 3 summarizes literature search of price elasticities of demand of SSBs.

Therefore, consumer theory in economics and empirical data have proven that SSBs — similar to other addictive products such as tobacco and alcohol - are price elastic, i.e. an increase in price reduces its demand [70].
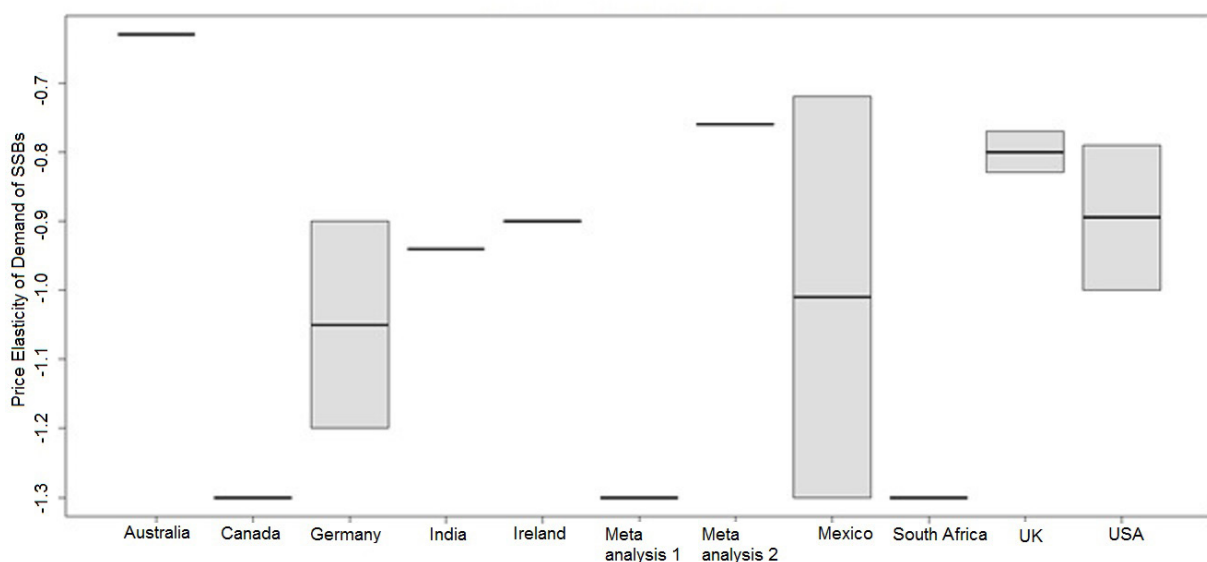

Figure 3. Results of a Literature Search on Price Elasticity of Demand of SSBs

3. Health benefits of SSB taxation

Of the 22 included articles, 20 focused on health impacts and found a reduction in energy intake and an improvement in health status after the introduction of a SSB tax (Table 2). SSBs are consumption products that do not provide any health benefits, but are, in fact, harmful to health: they increase the risks of contracting non-communicable diseases such as type 2 diabetes, hypertensive heart diseases, strokes, ischemic heart diseases, and hypercholesterolemia.

A. In lower-middle income countries

In India, Basu et al. estimated that the introduction of a 20% SSB tax would reduce the prevalence of overweight and obesity by 3.0% (95% CI [1.6%, 5.9%]) and the incidence of type 2 diabetes by 1.6% (95% CI [1.2%, 1.9%]) within 10 years. The authors predicted that the reduction of caloric intake would be the most significant among young people, males, and those living in rural populations. Furthermore, they predicted that the 20% SSB tax would induce a greater decline of type 2 diabetes rates among urban individuals compared to rural individuals [69].

B. In upper-middle income countries

Mexico has the world's highest prevalence of obesity and diabetes, thus as a result, the government of Mexico created a systematic action plan against these public health issue in 2014. As part of this policy intervention, an excise tax of 10% on SSBs (one Mexican peso per liter) was implemented [56]. Within 10 years, the expected health impacts of this tax are: an average reduction of 8.38 kcal daily intake per capita, an overweight prevalence reduction of 0.51%, an obesity prevalence reduction of 2.54%, and a decrease of 1.7-6.8% for the incidence rate of diabetes [56, 57].

South Africa has the highest obesity prevalence in their region, and the consumption of SSBs has steadily increased in the past 30 years. In July 2016, to tackle this public health issue, the South African National Treasury proposed a 20% excise tax on SSBs containing more than 4g of added sugar per 100 mL. The tax was introduced on April 1, 2017 and became the first soda tax in Africa. According to Manyema et al., the expected health impacts of this tax within 20 years are: an average reduction of 8.6 kcal daily energy intake per capita, a reduction of obesity prevalence of 2.4% among women and 3.8% among men, a reduction of diabetes prevalence of 4.0%, a decrease in stroke

prevalence of 1.03% among men and 1.55% among women, a decline of the stroke related mortality of 1.07% among men and 1.76% among women. Cumulatively, over 20 years, they estimated that 21,000 deaths related to diabetes could be avoided and R10 billion ZAR (860 million USD) in health care costs related to diabetes could be saved [58-60].

C. In high-income countries

In Germany, Schwendicke et al. estimated that a 20% excise tax on SSBs would lead to a 3.0% decrease in overweight prevalence and a 4.0% decrease in obesity prevalence among individuals aged 15-79. Furthermore, the authors found a more significant decrease in overweight and obesity prevalence among young people of lower-income households [68].

In Canada, Jones et al. estimated that a 20% tax on SSBs would decrease the daily energy intake per capita of 21 kcal (95% CI [19, 23]) among adult males and 13 kcal (95% CI [12, 15]) among adult females within 25 years. They also estimated a BMI reduction of 0.30 among men and of 0.22 among females; these small reductions in BMI would prevent an average of 69,600 overweight cases and 400,000 obesity cases [67].

In Ireland, Briggs et al. estimated that a 10% SSB tax would reduce the daily energy intake per capita by 2.1 kcal, leading to a 1.3% reduction of the adult obese population (i.e. 9,900 cases) and to a 0.7% reduction of the adult obese or overweight population (i.e. 14,380 cases) [66].

In Australia, Veerman et al. analyzed the impacts of a 20% ad valorem tax on SSB (based on value of prices and not on volumes), assuming its effective introduction in 2010. The authors presented the change in outcome of various obesity related diseases and of health care expenditures. They found that the daily energy intake per capita would decrease by 1.4 kcal among men and by 2.2 kcal among women; the obesity prevalence would decrease by 1.2% to 2.7%; annual savings on health care expenditures would be $609 million AUD (i.e. $495 million USD); and the annual government fiscal revenues would increase by $400 million AUD [65]. Sharma et al. investigated the effects of this 20% valoric tax on SSB on individuals collecting meals. They found, if the main shopper of the household is female, that household would devote a larger share of their budget on diet drinks; if the main shopper is young (<40 years old) or has a full-time job, that household would allocate a higher share of their budget on soft drinks. Among heavy SSB

drinkers, the reduction of BMI is more significant among low-income households (2.1) compared to middle (1.9) and high-income (1.1) households [49].

The authors also found that the burden of this SSB tax would be higher among low-income households ($17.87 AUD, 0.21% of annual income) compared with high-income households ($15.17 AUD, 0.07% of annual income) [64]. Lin et al. reported similar results for the USA: a heavier tax burden for low-income households ($19.97 USD, 1.0% of food expenditures) compared with high-income households ($18.84 USD, 0.6% of food expenditure) [49].

In the USA, Kristensen et al. used micro simulation models to evaluate a group of interventions (after school physical activity, advertisement bans, and a SSB excise tax) to reduce obesity among 6-18 year olds. They found that an excise tax was the most effective way to curb obesity among the 13-18 year olds, while after school physical activity was the most efficient among the 6-12 year olds. Oddly enough, banning fast-food advertisements on TV has the least effect on reducing childhood obesity [61].

In California, USA, Mekonnen et al. analyzed the effects of a SSB excise tax on the mortality and morbidity of cardiovascular diseases. They found that within 10 years, a 10-20% decrease of SSB consumption would lead to a 1.8 to 3.4% reduction of diabetes incidence and a 0.5 to 1.0% reduction of coronary heart disease among high-risk populations [63].

In New York City, USA, Ruff et al. studied the impact of a SSB excise tax on BMI. Applying a dynamic weight loss model on 2012 body mass data, they found an average of 0.46 kg reduction after one year and 0.92 kg after ten years. They also reported that the introduction of a 1 cent per ounce SSB tax would save 32,300 life-years over ten years, avert 101,000 DALYs, gain 871,000 QALY, and reduce health care costs related to obesity by $23.6 billion USD [47].

Discussion

To tackle the major public health issue of overweight and obesity, many countries in Asia-Pacific, Europe, South America, and North America have already introduced a "sugar-tax" at various levels and in various forms, based on each county's economic status and sociopolitical environment [20-50]. Articles included in our systematic literature review have used or estimated negative

PED, ranging from -0.63 to -1.3, and have shown the associated decrease in BMI and prevalence of overweight and obesity.

Current evidence suggests that increasing the prices of SSBs through an excise tax would induce many benefits: decreased consumption of SSBs, reduction of overweight and obesity related chronic diseases, savings on health care spending related to associated non-communicable diseases (obesity, diabetes, and chronic cardiovascular diseases such as stroke and coronary heart diseases), and an increase in the government fiscal revenues. Furthermore, research has shown that even a minimal reduction in BMI has the potential power to change an individual's weight status from obesity to overweight and from overweight to normal weight [64, 65].

We must bear in mind that international evidence shows that taxation can be an effective policy lever if used as part of an integrated policy response utilizing a range of additional policy levers and interventions, such as health promotion, health prevention, and early intervention activities. Subsidies, cash incentives, restrictions on purchase and use, information access, and advertising restrictions constitute a suite of measures that could promote the reduction of SSB consumption and health risky behaviors.

Most studies in the literature have so far focused on the impacts of SSB taxation among high- and upper-middle income countries, but not many studies have examined such impacts in lower-middle or low-income countries. Within countries that have been studied, evidence have so far shown that the most responsive an excise tax on SSBs – and thus, those who benefits the most – are young individuals living in rural areas or of lower socioeconomic status [56-60]. Only one study found comparable reductions of BMI across all genders and socioeconomic statuses [66]. Among low-income countries, there is a positive association between socioeconomic status and obesity; obesity is more prevalent among the higher socioeconomic groups than lower socioeconomic groups [12]. Conversely, in high- and middle-income countries, obesity is more prevalent among the lower socioeconomic groups [14]. This discrepancy calls for research focused specifically on lower-middle and low-income countries to study the potential economic and health benefits of an SBB tax in these countries.

Considering the low-middle income status, studying the impact of an excise tax on SSB in Mongolia would be all the more innovative and informative. In Mongolia, the prevalence

of overweight and obesity has increased severely from 2010 to 2017: from 6.6% to 12% for children under five, from 4.3% to 28% for children aged 7-11 years, from 49.3% to 64% for men aged 15-49 years, and from 32.9% to 63% for women aged 15-49 years [16, 17]. In a country where obesity and overweight is a booming threat to the general population, it is important to be able to estimate the economic and health effects using country-specific PED and socio-economic characteristics. This literature review is the first step towards understanding the potential benefits of an SSB tax in Mongolia and informing the future policies of Mongolia and similar countries.

Conflict of Interest

The authors state no conflict of interest.

Acknowledgements

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